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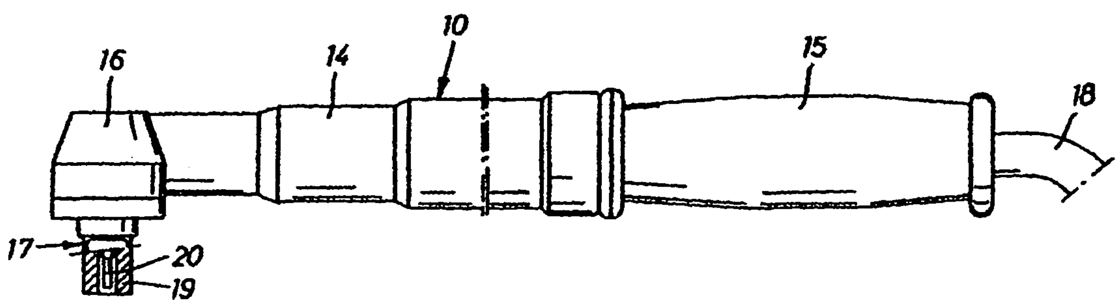
(54) Title: SYSTEM FOR TIGHTENING FASTENERS HAVING ULTRA-SONIC SOUND WAVE GENERATING AND SENSING MEANS



(57) Abstract

A torque application system intended for tightening a threaded fastener (12) having a rear end surface with an integral ultra-sonic sound wave generating and sensing device (21), which comprises a power wrench (10) with an output shaft (17) provided with a pin-shaped contact device (20) for delivering and receiving electric signals, and a set of torque transferring nut sockets (11a, 11b) each having a forward socket portion (22) for connection to the fastener head, a rear socket portion (23) for connection to the power wrench output shaft (17), and a central portion (24, 26) separating the forward and rear portions (22, 23), wherein each one of the torque transferring nut sockets (11a, 11b) carries a probe unit (28) with a rear extremity (29) extending into the rear socket portion of the nut socket (11), and a forward extremity (30) extending into the forward socket portion (22) of the nut socket (11a, 11b), wherein the forward extremity (30) is telescopically extendible by spring force for establishing contact with the sound wave generating and sensing device (21) on the rear end surface of the fastener head when interconnecting the output shaft (17) with the fastener (12a, 12b) by means of anyone of the set of nut sockets (11a, 11b).

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System for tightening fasteners having ultra-sonic sound wave generating and sensing means.

The invention relates to a system for tightening fasteners of the type having integrated ultra-sonic sound wave generating and sensing means by using a power wrench carrying a torque transferring nut socket, wherein a probe unit is used for transferring electrical signals between the power wrench and the fastener past the nut socket.

A problem with this technique, as it is previously described in for instance US 4,846,001, is the difficulty to adapt the signal transferring probe unit to nut sockets of different dimensions. As illustrated in this patent, the probe unit is mounted in the output shaft of the power wrench, and the extremity of this probe extends axially right through the nut socket to engage a contact surface on the fastener.

Depending on, for instance, specific locations of the threaded fasteners to be tightened there is required nut sockets of different length, and, accordingly, the probe unit has to have an extremity of different length to reach through to the fastener. Since the probe unit is mounted in the output shaft of the power wrench, the probe unit has to be exchanged when changing from a nut socket of one length to a shorter or longer nut socket. This is disadvantageous since it causes rather time consuming and costly production stops.

The main object of the invention is to provide an improved torque application system for tightening fasteners having integral electrically activated ultra-sonic sound wave generating and sensing devices, including a power wrench having an output shaft of a standard type provided with a contact means, and a set of nut sockets of different

dimensions all fitting the same output shaft shape and dimension, and wherein no time consuming rebuilt of the power wrench is required to adapt the signal transferring probe unit to different nut socket dimensions.

Further characteristics and advantages of the invention will appear from the following specification in which a preferred embodiment of the invention is described in detail.

On the drawings

Fig. 1 shows a side view of a power nutrunner forming part of the invention.

Fig. 2 shows, on a larger scale and partly in section, the output end of the power nuturunner shown in Fig. 1.

Fig. 3a shows a longitudinal section through a nut socket forming part of the invention, as well as a threaded fastener to be engaged by the nut socket.

Fig. 3b shows a longitudinal section through another nut socket also forming part of the invention, as well as a threaded fastener to be engaged by the socket.

Fig. 4a shows, on a larger scale and partly in section, a nut socket probe unit according to the invention.

Fig. 4b shows, on a larger scale and partly in section, an alternatively designed probe unit according to the invention.

The torque application system shown in drawings comprises mainly an electrically powered angle nutrunner 10 and a set of nut sockets 11a, 11b etc. of different sizes and lengths for engaging threaded fasteners like screws 12a, 12b etc. The power nutrunner 10 comprises a housing 14, a handle 15 and an angle head 16 with an output shaft 17. The latter is formed with a connection portion 19 of square cross section for connection to a standard type nut socket.

The nutrunner housing 14 contains an electric motor (not shown) which via a reduction gearing is connected to the angle head 16 and the output shaft 17 and which is supplied with electric power via a cable 18 connected to the nutrunner through the handle 15. The cable 18 connects the nutrunner 10 to a remotely located operation control unit, including power supply means.

The output shaft 17 is provided with a central contact element 20 which via a separate wiring through the nutrunner and the cable 18 is connected to the operation control unit which also include means for generating and detecting electrical pulses. As described above in connection with previously known technique, each one of the threaded fasteners to be tightened by this system comprises an electrically activated ultra-sonic sound wave transducer 21. The latter is of a piezo-electric type and is formed integrally with the head of the fastener 12a,12b etc.

In operation, electric pulses are delivered to the sound wave generating means of the fasteners 12a, 12b etc. so as to produce ultra-sonic sound wave pulses through the fasteners. The reflected sound waves are transformed to electric pulses by the integral sound wave sensing means on the fasteners, and these electric pulses are fed back to the operation control unit via the contact element 20, the internal wiring in the nutrunner 14 and the cable 18. In a well known manner, the travel time of the sound waves through the fastener is calculated, and the actual axial load on the fastener is determined.

Each one of the nut sockets 11a, 11b etc. comprises a forward socket portion 22, a rear socket portion23, and a central portion 24. The forward socket portion 22 is formed to fit the head of the fastener 12, usually of a hexagonal cross section, and having an axial extent substantially

identical with the axial extent of the fastener head. The axial extent of the forward socket portion 22 is defined by a shoulder 25. The rear socket portion 23 is of a square cross section to receive a standard type square ended nutrunner output shaft 17. The central portion 24 is the part of the nut socket that separates the forward socket portion 22 from the rear socket portion 23 and comprises a sleeve insert 26.

In order to establish electric contact between the contact element 20 in the output shaft 17 and the fastener, each one of the nut sockets 11a,11b etc. is provided with a probe unit 28 which is secured in the sleeve insert 26 of the central portion 24. According to the embodiment shown in Figs. 3a, 3b, 4a, this probe unit 28 has a rigid rear extremity 29 for co-operation with the contact element 20 of the output shaft 17, and a telescopically extendible forward extremity 30 which is axially biassed by a spring 31 to its extended position for getting into a proper contact with the fastener.

As clearly shown in Fig. 4a, one type of probe units 28, irrespective of the length of the nut socket, comprises a sleeve element 32 which is rigidly secured in the sleeve insert 26, and a spring 33 located inside the sleeve element 32 and acting on the rear end of the forward extremity 30. The latter is limited in its forward movement by a shoulder 36 engaging a inner shoulder 37 in the sleeve element 32. In this example, the sleeve element 32 forms the rear extremity 29.

For adapting the nut sockets to different fastener types and locations, there is provided a number of nut sockets 11a, 11b etc. of different length, and in order to maintain a proper contact between the contact element 20 in the nutrunner output shaft 17 as well as with the sound wave

transducer 21 on fastener head, the length of the probe unit 28 is likewise adapted to the nut socket length.

As described above, the rear extremity 29 of the probe unit 28 is formed by the sleeve element 32 which is immovably secured to the sleeve insert 26 in the nut socket, whereas the forward extremity 30 is axially extendible and/or depressible to maintain a proper co-operation with the sound wave transducer 21 on the fastener. Due to the fact that the rear extremity 29 of the probe unit 28 is immovable, the contact element 20 in the nutrunner output shaft 17 is axially movable to ensure a proper co-operation with the probe unit 28. It is essential, though, that the length of the rear extremity 29 is equal in all nut sockets, irrespective of the nut socket length, so as to fit the contact element 20 in the output shaft 17.

In the alternative probe unit design shown in Fig. 4b, both the forward extremity 30 and a rear extremity 38 are movably supported relative to a sleeve element 39 which is secured in the sleeve insert 26 of the nut socket. The rear extremity 38 is limited in its rearward extension by a shoulder 40 co-operating with an internal shoulder 42 in the sleeve element 39. When using this type of probe unit, the contact element 20 of the output shaft 17 does not have to be movable. A spring 43 acts between the inner ends of the two probe extremities 30,38 to accomplish an axial expansion of the probe unit 28.

By the nut socket and probe unit arrangement according to the invention, there is obtained a uniform interface between the nutrunner output shaft 17 and the nut sockets 11, which is important in widening the range of use of the nutrunner 14 to nut sockets of different sizes and lengths. Changing from one type of nut sockets to another may easily

be done without causing any production interfering rebuild of the output shaft 17.

Claims.

1. Torque application system for tightening a threaded fastener (12a,12b) having an end surface with an integral ultra-sonic sound wave generating and sensing device (21), comprising a power wrench (10) with an output shaft (17) provided with an electric contact device (20) for delivering and receiving electric signals, and a set of interexchangeable torque transferring nut sockets (11a,11b) each having a forward socket portion (22) for connection to said fastener, a rear socket portion (23) for connection to said output shaft (17), and a central portion (24,26) separating said forward socket portion (22) and said rear socket portion (23),

c h a r a c t e r i z e d in that each one of said nut sockets (11a,11b) comprises a contact probe unit (28) which extends coaxially through said nut socket (11a,11b) and which is secured to said central portion (24,26), said probe unit (28) has a rear extremity (29) extending into said rear socket portion (23), and a forward extremity (30) extending into said forward socket portion (22), and said forward extremity (30) is telescopically extendible for establishing electric contact with said sound wave generating and sensing device (21) on said fastener head at interconnection of said output shaft (17) and said fastener head by means of said nut socket (11a,11b).

2. Torque application system according to claim 3, wherein said rear socket portion (23) of each one of said nut sockets (11a,11b) is of a standard shape and dimension fitting the standard type output shaft (17) of a conventional power wrench, whereas the forward socket portion (22) is individually adapted to a certain fastener head shape and dimension.

3. Torque application system according to claim 2, wherein said forward socket portion (22) of each one of

said torque transferring implements (11a,11b) comprises an internal shoulder (25) for limiting the penetration depth of said fastener into said forward socket portion (22).

4. System for applying torque to and measuring the pre-tension level in a threaded fastener (12a,12b), comprising a power wrench (10) with an output shaft (17) formed with a connection portion (19),
an electric contact (20) carried on said connection portion (19),
an electrically activated ultra-sonic sound wave generating and sensing device (21) formed integrally with said fastener (12a,12b) and having a contact surface,
a set of interexchangeable nut sockets (11a,11b) each being attachable to said connection portion (19) for transferring a tightening torque from said output shaft (17) to said fastener (12a,12b),
each of said nut sockets (11a,11b) comprises a rear socket portion (23) for receiving said output shaft connection portion (19), a forward socket portion (22) for driving connection to said fastener (12a,12b) and a central portion (24,26) separating said rear socket portion (23) and said forward socket portion (22),
c h a r a c t e r i z e d in that each one of said nut sockets (11a,11b) is provided with a probe unit (28) secured to said central portion (24,26) and comprising:
a first extremity (30) extending co-axially into said forward socket portion (22) for engaging said contact surface on said ultra-sonic sound wave generating and sensing device (21), and
a second extremity (29;38) extending co-axially into said rear socket portion (23) for engaging said electric contact (20) on said connection portion (19),
said first extremity (30) being telescopically extendible by a bias spring (33;43), whereby is obtained an electrical contact between said contact surface of said ultra-sonic

sound wave generating and sensing device (21) on said fastener (12a,12b) and said connection portion contact (20) on the power wrench (10).

5. System according to claim 4, wherein said second extremity (38) is axially depressible against the action of a bias spring (43).

6. System according to claim 4 or 5, wherein said forward socket portion (22) of each one of said nut sockets (11a,11b) is formed with a shoulder (25) for limiting the penetration depth of said fastener (12a,12b) into said forward socket portion (22).

7. A set of interexchangeable nut sockets (11a,11b) for connecting the output shaft (17) of a torque delivering tightening tool (10) to threaded fasteners (12a,12b) each carrying an ultra-sonic sound wave generating and sensing device (21), said output shaft (17) having an electric contact element (20), wherein each one of said nut sockets (11a,11b) comprises:
a forward socket portion (22) for engagement with said threaded fastener (12a,12b),
a rear socket portion (23) for connection to said output shaft (17), and
a central portion (24,26) separating said forward socket portion (22) and said rear socket portion (23),
c h a r a c t e r i z e d in that each one of said nut sockets (11a,11b) is provided with a co-axially extending electric probe unit (28) which is rigidly secured in said central portion (24,26), said probe unit (28) having a first contact pin (30) extending into said forward socket portion (22) and being telescopically extendible by spring force for establishing contact with said sound wave generating and sensing device (21), and a second contact pin (29) extending into said rear socket portion (23) for

establishing an electric contact with said output shaft contact element (20) at interconnection of said output shaft (17) and said fastener (12a,12b) by means of said nut sockets (11a,11b).

FIG 1

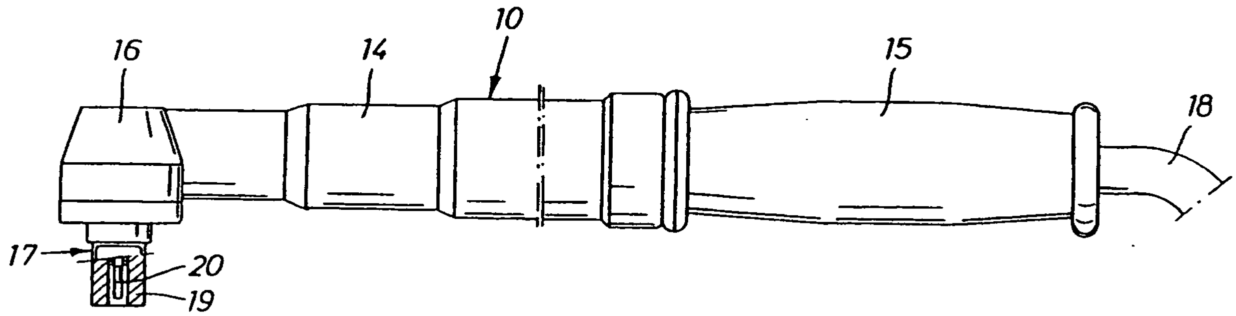


FIG 4a

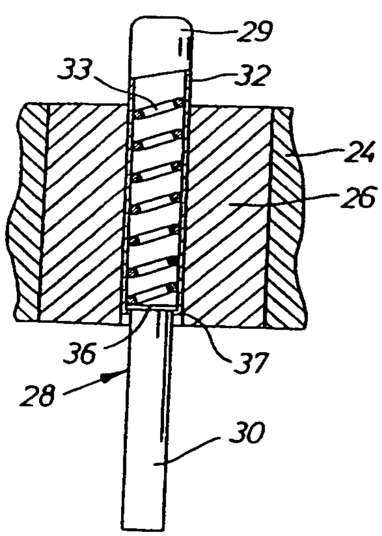


FIG 4b

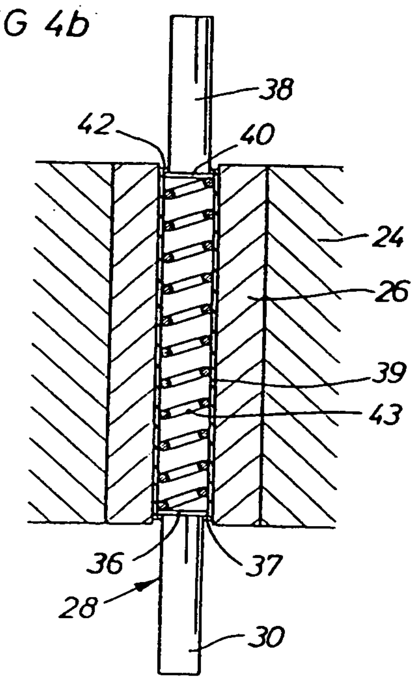


FIG 2

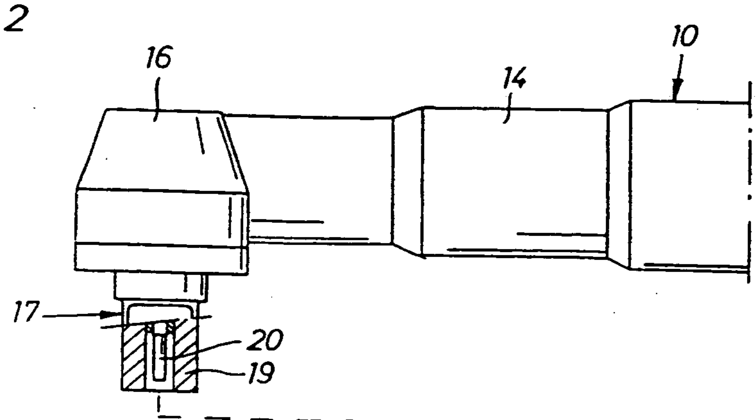


FIG 3a

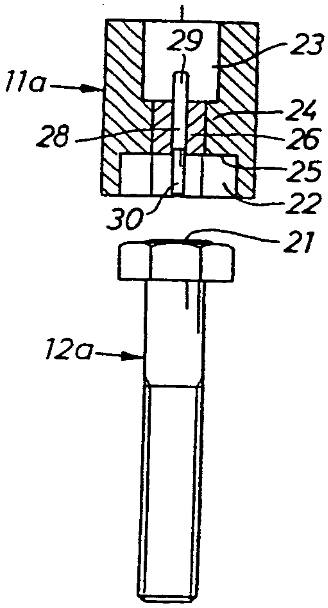
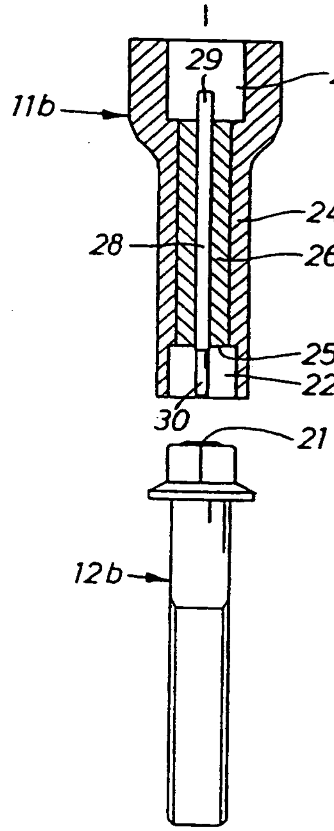


FIG 3b



INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 00/00800

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B25B 23/14, G01L 5/24 // G01L 1/16, B25B 23/00, B25B 23/142
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B25B, G01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9609525 A1 (CRANE ELECTRONICS LIMITED), 28 March 1996 (28.03.96), figure 3, abstract, page 5, 3rd and 4th paragraph --	1-7
A	SE 510355 C2 (ROBERT BOSCH GMBH), 17 March 1996 (17.03.96), figure 1, abstract --	1,4,5
A	US 5699703 A (MICHAEL HABELE), 23 December 1997 (23.12.97), column 4, line 16 - line 45, figure 3, abstract --	1-7
A	EP 0589271 A1 (ROBERT BOSCH GMBH), 30 March 1994 (30.03.94), figure 1, abstract --	1,4

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Information on patent family members

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International application No.
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9609525 A1	28/03/96	GB 2293698 A,B	03/04/96
		GB 9419234 D	00/00/00
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